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A SOLID sphere and a solid cylinder of equal radii roll from rest down the same inclined plane; compare the times of their descent.

[*Artemas Martin.*]

SOLUTION.

By the principle of vis viva,

$$mv^2 + I\omega^2 = 2mgs \sin i\,.$$

The motion being pure rolling,

$$v = r\omega\,.$$

For the sphere,

$$I = \tfrac{2}{5}\,mr^2\,.$$

For the cylinder,

$$I = \tfrac{1}{2}\,mr^2\,.$$

Substituting these values and reducing, we have, for the sphere,

$$v = \frac{ds}{dt} = \sqrt{\tfrac{5}{14}\,gs \sin i}\,;$$

and for the cylinder,

$$v = \frac{ds}{dt} \cdot = \sqrt{\tfrac{1}{3}\,gs \sin i}\,.$$

Integrating, we get

$$\sqrt{s} = t\sqrt{\tfrac{5}{14}\,g \sin i}\,, \qquad \sqrt{s} = t'\sqrt{\tfrac{1}{3}\,g \sin i}\,;$$

whence

$$\frac{t}{t'} = \sqrt{\tfrac{14}{15}}\,.$$

[*S. T. Moreland; M. C. Andrews; C. E. Mendenhall; G. R. Dean.*]

EXERCISE.

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GIVEN $\tan_\kappa w = x + iy$, wherein

$$\tan_\kappa w = \kappa\,(e^{w/\kappa} - e^{-w/\kappa})/(e^{w/\kappa} + e^{-w/\kappa})\,,$$

$$w = u + iv\,, \quad i = \sqrt{-1}\,,$$

and

$$\kappa = m\,(\cos\beta + i \sin\beta)\,;$$

determine u and v as real quantities in terms of x, y, m, and β.

[*Irving Stringham.*]